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Pahala Blight.

By H. L. Lyon.

Pahala blight of the sugar cane is a type of chlorosis induced by a factor or factors resident in the soil.

Chlorosis signifies a derangement of the chlorophyll (green coloring matter) in a plant which becomes apparent through the diminution, destruction or total absence of the green color in the tissues. Five types of chlorosis appear in Hawaiian cane fields.

Inherent chlorosis is due to a loss on the part of the protoplasm, or living substance, of the ability to produce chlorophyll. If the living substance throughout all of the embryonic tissue of a cane plant loses the power to generate chlorophyll, this tissue can then give rise to white leaves only and the plant soon dies of starvation through inability to compound starch and sugar. When canes are grown from seed on any considerable scale, individual seedlings will frequently appear which never produce any green leaves at all, their tissues throughout being white or yellowish. All such seedlings die when the nourishment supplied by the seed is exhausted.

When loss of ability to generate chlorophyll extends to only a portion of the embryonic tissue of a shoot, the result is leaves with white and green stripes of varying widths, and we say that the leaves are variegated. Many well-known varieties of cane habitually produce variegated leaves, and an occasional variegated shoot may be found in any variety. When variegated canes are grown on any considerable scale, individual shoots are certain to occur, the embryonic tissue of which has entirely lost the chlorophyll-producing power. These shoots have white leaves and survive only through support derived from other shoots in the stool. Needless to say, it is impossible to propagate a cane with only white leaves.

The well-known Yellow Stripe disease is an infectious chlorosis attacking canes of all ages, of all varieties and in all districts. It is caused by some parasitic agent as yet undetermined.

Lime-induced chlorosis appears in canes grown in soil containing an excess

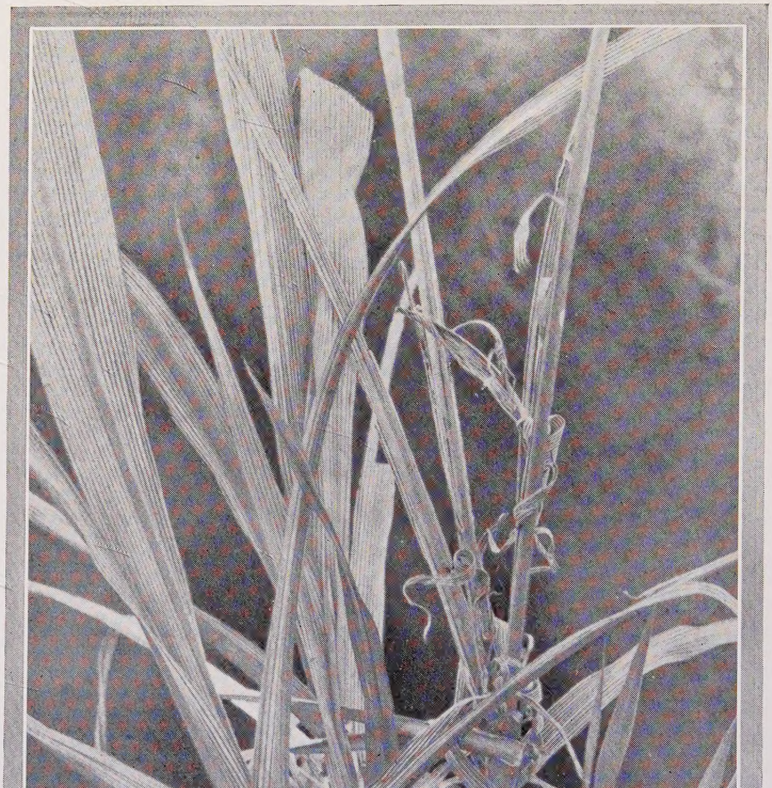

Fig. 1. A stool of cane in an advanced stage of Pahala Blight.

of calcium carbonate. It only occurs in lowland fields at points where there is an outcrop of ancient coral. Under such conditions canes once green may lose all of their chlorophyll, the leaves becoming quite white. Cuttings from such canes when planted in good soil give rise to normal green shoots.

A chlorosis of young ratoon shoots occurs quite extensively, particularly on the Island of Oahu. In this case the leaves of the young shoots are quite white when they unroll and they may remain so and die or they may eventually become green. If the first shoots to appear from the old stool do not recover they are soon followed by green shoots which grow normally, so while this chlorosis may cause a delay in the starting of the ratoon crop, it does not, as a rule, appreciably affect the ultimate stand.

Pahala blight is an induced chlorosis which may afflict a cane plant at any stage in its growth. It is characterized by paling or whitening of the tissue of the leaves in definite narrow stripes, these stripes alternating with green stripes of about equal width as may be seen in Fig. 1 and the illustration on the cover. This type of chlorosis has been noted in cane fields in various parts of these Islands and also in other cane-growing countries. In most localities it is but a temporary derangement of the green tissues in the leaves, which eventually regain their normal green color and the plant suffers no permanent injury. In Pahala, however, this type of chlorosis appears regularly in every crop on certain fields and often persists for such periods as to very seriously injure the crop; in fact, it not infrequently causes the complete failure of the canes on considerable areas.

Data Previously Recorded.

Pahala blight has been known as long as cane has been grown on a commercial scale in Pahala. At a very early date it was definitely established that the disease was not spread throughout the district, but occurred on certain sharply-defined areas only. It was also early noted that the trouble seemed to develop to its greatest intensity only when certain climatic conditions prevailed, the essential factors being continuous cloudy, wet weather, and that the cessation of these conditions was always followed by immediate improvement among diseased canes.

Pahala blight was studied by Dr. N. A. Cobb* during 1905-1906. He named it *"leaf-splitting blight"* and published a very full description accompanied by some excellent illustrations which tell better than words how the disease may be recognized in the field. His description is slightly inaccurate in certain details, however, and his conclusion quite erroneous in so far as the cause of the disease is concerned. He describes a new fungus, *Mycosphaerella striatiformans,* as a parasite directly responsible for the malady. This fungus proves to be a saprophyte which enters the tissues of a cane leaf only after these tissues have died from Pahala blight or some other cause. During the early stages of Pahala blight no parasitic organisms can be found in the affected tissues, and *M. striatiformans* does not, by any means, appear in all leaves that succumb to Pahala blight.

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* Experiment Station, H. S. P. A., Division of Pathology and Phys. Bulletin 5, pp. 93-106, Bulletin 6, p. 103, pl. VII.

Structure of a Cane Leaf.

To clearly understand the exact course of the disease in a cane leaf we must first understand the structure of the leaf and the disposition of the chlorophyll therein.

Vascular bundles constitute the framework about which the other tissues of the cane leaf are disposed, certain tissues being associated with each bundle according to a rather definite plan, forming a structural unit. The bundles are of several different sizes and the complexity of the unit increases with the size of the bundle around which it is built. The tissues associated together in one of these structural units may be noted by referring to Fig. 2. There is always present the essential vascular tissue, vessels and sieve tubes, which is completely surrounded by a layer of large cells with rather thick walls constituting the bundle sheath, and this in turn is enclosed in a layer of thin walled cells which are densely packed with chlorophyll.

Vascular tissue, bundle sheath and chlorophyllous tissue are the essential tissues always present in a structural unit of the leaf, no matter how small or how large that unit may be. Additional complexity is added to the larger units by an increase in the size and number of cells in each essential tissue and the interpolation of sclerotic tissue or fiber cells at various points to give mechanical strength to the unit, as seen at 6 and 9 in Fig. 2.

Now, in a cane leaf these structural units of different diameters run parallel and in such close proximity to each other as to form a continuous layer throughout the blade of the leaf. In this layer of parallel units there occur at uniform intervals very large units which we may term major units. These major units are practically cylindrical and of such large diameter that they cause the upper epidermis to be elevated in order to accommodate them. They always contain a large amount of sclerotic tissue and constitute the chief strengthening members in the leaf. They occur from 2 to 3 millimeters apart and run quite parallel through the wings of the leaf blade.

From the foregoing description of the structure of a cane leaf it will be noted that the chlorophyll is segregated in a very definite tissue which is disposed in a layer around each and every vascular bundle in the leaf.

In Pahala blight it is the chlorophyll that is directly affected.

Pathogenesis.

Pahala blight is in effect a bleaching and destruction of the chlorophyll. As a rule the chlorophyllous tissues around the minor vascular bundles only are affected, the green tissues around the major bundles becoming involved only at a late stage in the disease. As a result a newly affected leaf displays a very definite striped appearance, green stripes alternating with yellowish-green or white stripes.

In the affected tissues the chloroplasts first lose their definite outline, then run together in a pale yellowish green mass and finally lose all semblance of green color.

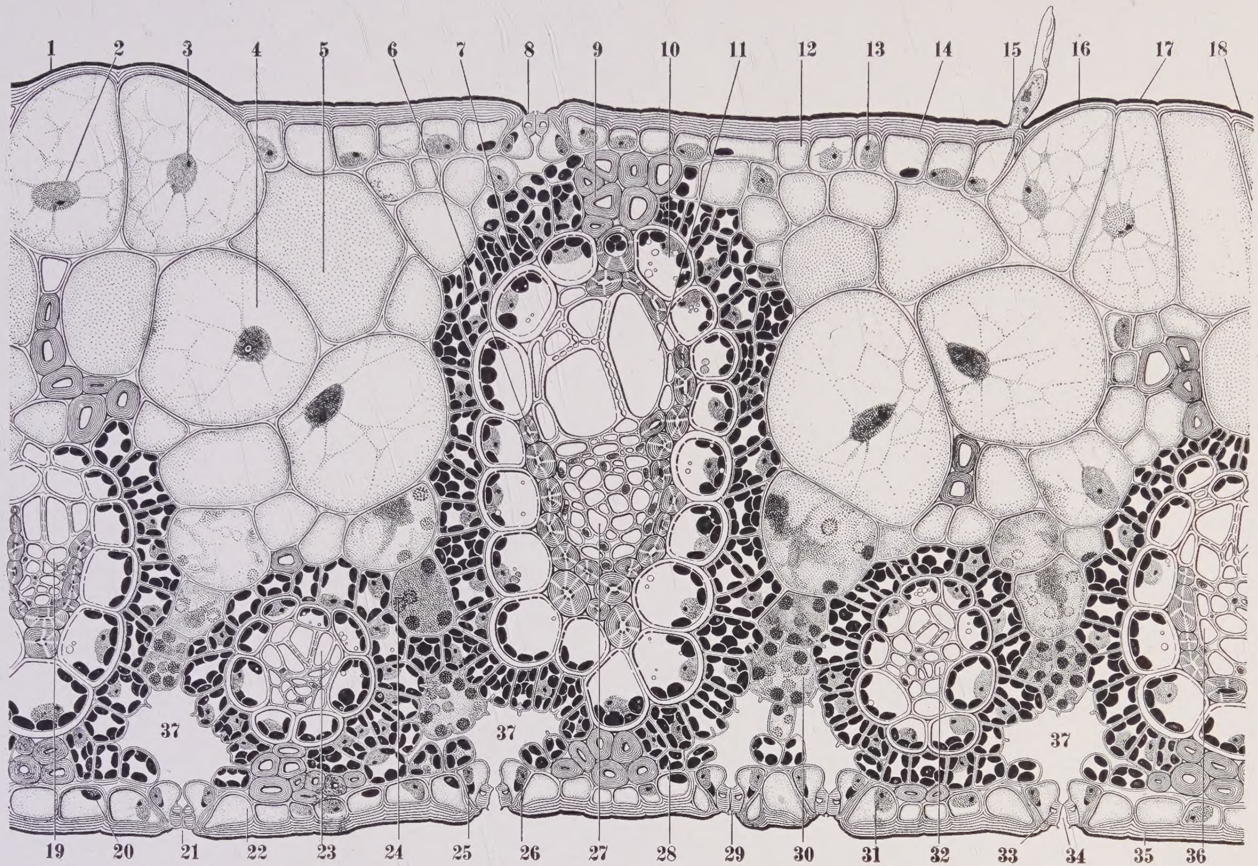

Fig. 2. Cross-section of a small portion of a cane leaf showing several minor vascular bundles. The vascular tissue is pointed out at 11, 19, 23, 27, 32 and 36; the bundle-sheath at 10; the chlorophyllous cells at 7 and sclerotic cells at 6 and 9. The chloroplastids, which are green in the leaf, are shown as black bodies in the figure.

The first indication of an attack of Pahala blight noticeable in a cane leaf is a paling or bleaching of the green tissue at the proximal ends of the minor vascular bundles. The bleaching proceeds upward and outward through the blades of the leaf along these bundles, producing light stripes of uniform width which may eventually extend to the very margin of the leaf. The progress of the disease may be slow or very rapid. In some cases the paling of the tissue in the stripe is very gradual and may not proceed beyond a light greenish yellow; in other cases the paling is very rapid, the tissues being quickly bleached to a sickly, yellowish white.

A cane shoot may show a mild case of Pahala blight, continue in the same condition for months and eventually recover. Then again the disease may reach an acute stage only a short time after the first symptoms have become apparent, but the shoot usually lingers on for months before it finally succumbs. If the chloroplasts are seriously injured the tissues never recover, but die and are soon invaded by various saprophytic fungi. When canes become seriously affected by the blight they stop growing and remain practically dormant until the blight-factor ceases to operate, then they do not recover by rehabilitating the old tissue, but produce new and healthy tissue. Consequently canes often show a very abrupt transition from diseased to healthy tissue. One leaf may be badly marked by the blight and the very next younger leaf show no signs of the blight at all. Then, again, the upper portion of a leaf may be distinctly blighted, while the basal portion is quite free from blight. In such a case the basal portion has been produced after the blight factor ceased to operate.

Investigation of Pahala Blight.

The actual cause of Pahala blight has not been determined. Early in our experience with the malady, however, we obtained certain evidence which indicated that the bleaching of the green tissues in the leaves was due to some deleterious chemical agent taken up from the soil by the plant.

Analyses of soil from areas where the disease annually occurs have failed to reveal the causal factor. Tub experiments conducted in Honolulu on soils from blight areas have yielded only negative results. Finally we decided to conduct comprehensive experiments with these soils in the field. In these experiments we aim to apply laboratory methods but at the same time maintain field conditions.

The installation, progress and results to date of the first experiment of this nature are carefully described by Mr. W. L. S. Williams in the following pages.

This experiment gives us the first positive evidence yet obtained on the exact location of the causal factor of Pahala blight. Incidentally, it also shows what these lands actually produce in comparison with what they would produce if the blight factor could be nullified or eliminated.

Pahala Blight Investigations.

By W. L. S. Williams.

Hawaiian Agricultural Co. Observation Test D.*

Object. To avoid confusion and misunderstanding, it should be stated here that the object of this experiment is to obtain information, and that none of the treatments employed have at any time been considered as practical methods of combatting Pahala Blight. The experiment was designed to answer the following questions:

1. Can Pahala Blight be corrected by the incorporation of organic matter in the soil?
2. Is Pahala Blight caused by poisonous gases rising into the surface soil?
3. Does the cause of Pahala Blight reside in the surface soil or in the sub-soil?

Description of Experiment. For the location of the experiment, a section of Mission Field at an elevation of 1,500 feet above sea level was selected. This field is recognized at Hawaiian Agricultural Co. as being one of the most seriously and continuously blighted fields on the plantation. The crop harvested here in 1919 was Yellow Bamboo plant. It yielded an average of but 14 tons of cane per acre. This crop failure was due solely to the damage caused by Pahala Blight. On the section of the field where the experiment was installed the cane had been entirely killed out by the blight.

The variety of cane selected for the experiment was Yellow Bamboo, this variety being considered the most susceptible to blight. A second reason for planting this variety was the desire to avoid any possible complications induced by a rotation of varieties, the previous crop having also been Yellow Bamboo.

The installation of the experiment consisted in removing all surface soil from a space ten feet wide and eighty feet long. The depth of this surface soil varied from 12 inches at the upper end to 20 inches at the lower end. The surface soil was a fine sandy loam, while the sub-soil was a reddish brown clay loam, so the dividing line was easily followed. The sides of this excavation were entirely lined with half-ply rubberoid roofing paper, and the whole subdivided by strips of the same material into four plots, 10x20 feet in size. The purpose of the roofing paper was to prevent the lateral movement of soil water and gases from one plot to another, limiting this movement to the space directly below each plot. The plots were numbered from the upper end — 1, 2, 3, and 4.

1. In plot No. 1 (hereafter known as Organic Plot) a six-inch layer of mixed stable manure, press cake, and bagasse was inserted. This layer was then covered to the original level with the previously excavated surface soil. The purpose of this plot was to test the corrective value of organic matter for Pahala Blight.

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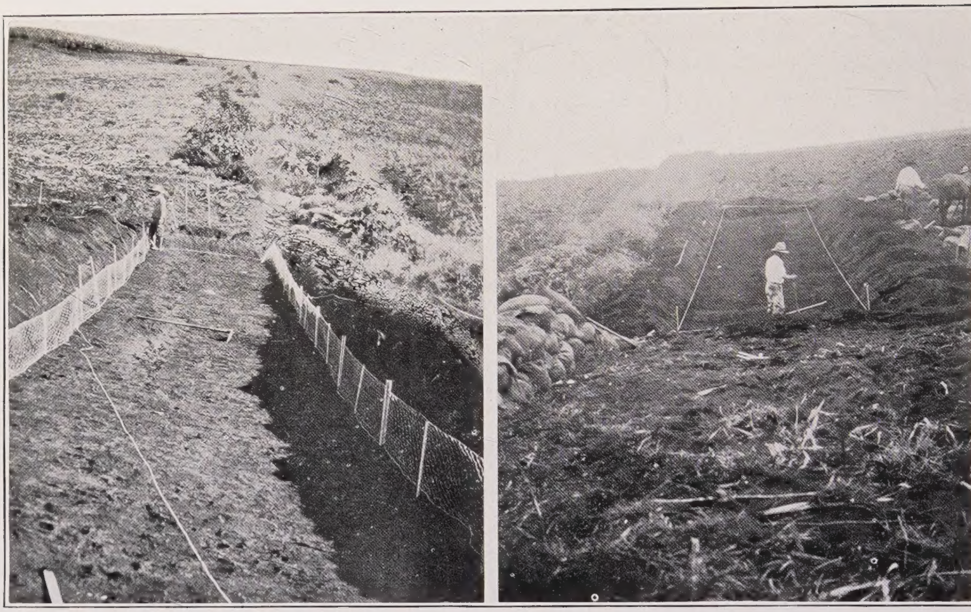
* Experiment planned by H. L. Lyon.
Experiment laid out by W. P. Alexander and W. L. S. Williams.

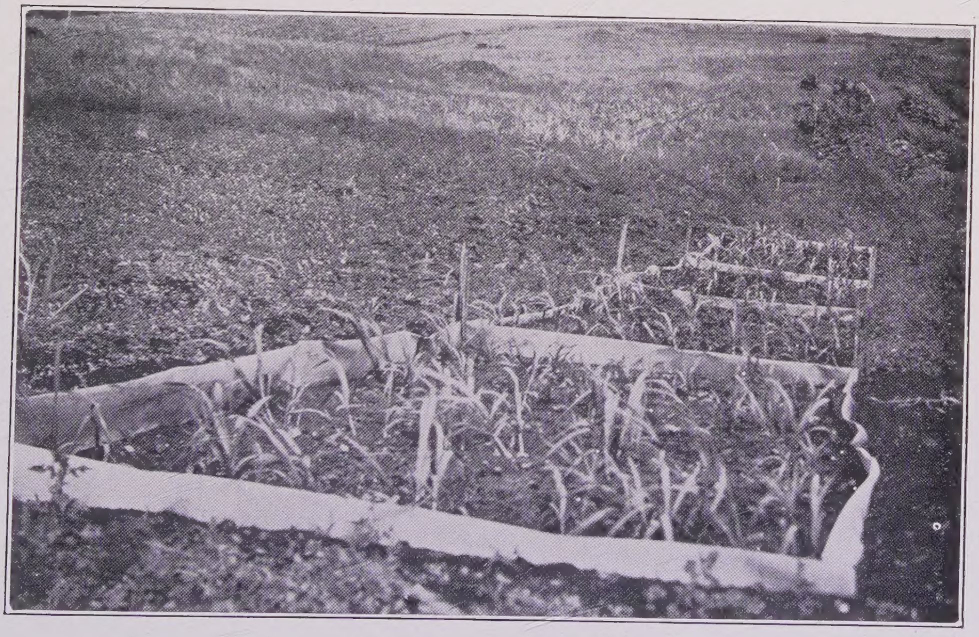
Installation of Excavation Experiments.



Photographs showing excavation made by removal of all surface soil from area where cane had previously failed to grow on account of Pahala Blight.

The excavation was divided into four compartments, which were lined with half-ply rubberoid roofing paper, wire netting being used to form a backing for the paper. The purpose of the roofing paper was to prevent the lateral movement of soil-water and gases from one plot to another.

All compartments are shown completely filled and ready to be planted with cane.



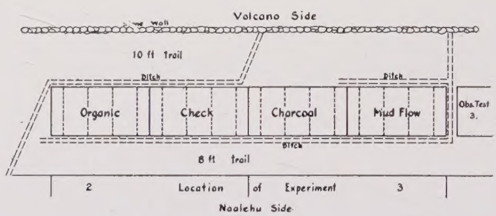
Photograph taken September 29, 1919. Mud flow plot is in foreground.

2. In plot No. 2 (hereafter known as Check Plot) the excavated surface soil was replaced without further treatment. The purpose of this plot was to act as a check on the other plots and to note the effect of handling the surface soil.

3. In plot No. 3 (hereafter known as Charcoal Plot) a six-inch layer of crushed charcoal was inserted. The charcoal was then covered to the original level with the previously excavated surface soil. The purpose of the charcoal was to act as a filter, to prevent injurious gases from rising into the surface soil from below.

4. In plot No. 4 (hereafter known as Mud Flow Plot) the excavation was filled with soil transported from Mud Flow Field—a field in which blight has never been known to occur. The purpose of this plot was to determine if the blight were induced by the sub-soil or by poisonous gases arising into the surface soil.

After completing the above, Yellow Bamboo seed was planted in all plots. Each plot had four lines of cane, each line 5 feet wide and 10 feet long. The following sketch shows the layout complete:



Observations have been made from time to time of the growth of cane, the number of shoots, and the degree of blight in the four plots. The following table gives the data from which graphical charts were plotted for the first year's results:

Date of Observation	Height of Cane to Tips of Leaves				Total Number of Shoots			
	Organic	Check	Char-coal	Mud Flow	Organic	Check	Char-coal	Mud Flow
	1	2	3	4	1	2	3	4
August 11, 1919	....	....	....	....	....	....	....	....
September 10, 1919 ...	14″	8″	10″	10″	83	40	48	92
September 29, 1919 ...	20″	12″	12″	12″	93	55	67	109
October 15, 1919	24″	12″	18″	18″	101	56	73	115
November 3, 1919	36″	24″	30″	30″	151	64	74	132
January 14, 1920	60″	30″	30″	36″	....	....	....	....
February 18, 1920	....	....	....	....	....	....	....	....
April 2, 1920	....	....	....	....	....	....	....	....
May 11, 1920	....	....	....	....	....	....	....	....
July 23, 1920	150″	36″	48″	114″	211	91	130	194

Date of Observation	Percentage of Blighted Shoots			
	Organic	Check	Char-coal	Mud Flow
	1	2	3	4
August 11, 1919	.....	.....	.....	.....
September 10, 1919	.....	.....	.....	.....
September 29, 1919	.....	.....	.....	.....
October 15, 1919	3.96	7.14	24.66	.....
November 3, 1919	4.63	51.56	48.65	.....
January 14, 1920	2.0	100.0	100.0	.....
February 18, 1920	1.15	100.0	100.0	1.28
April 2, 1920	16.66	100.0	100.0	4.22
May 11, 1920	14.43	100.0	100.0	2.84
July 23, 1920	12.32	100.0	100.0	.....

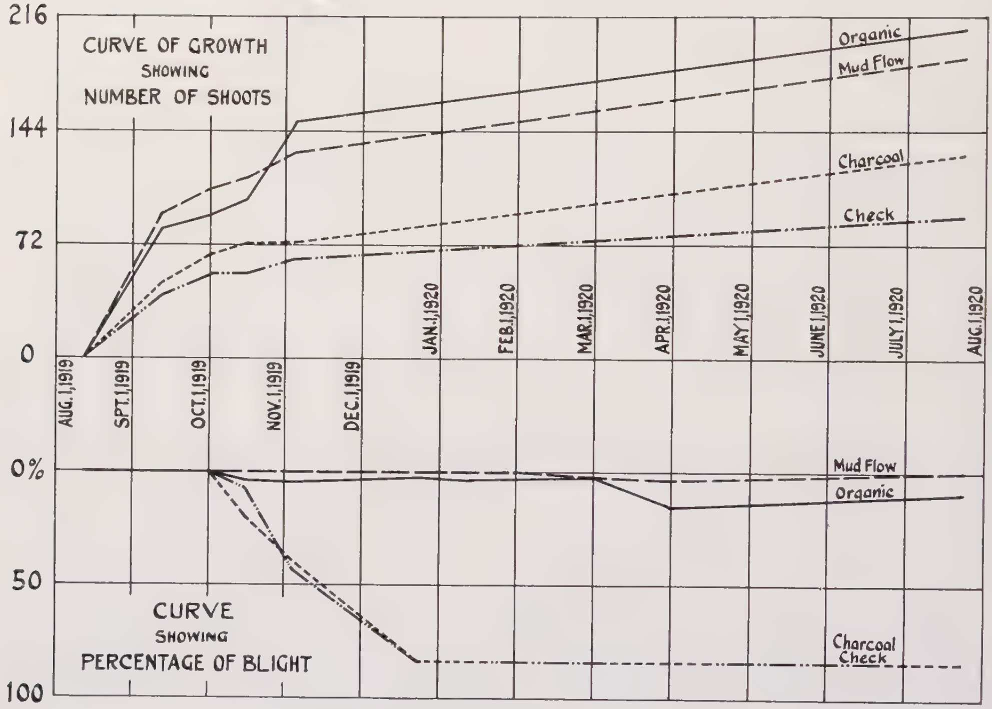
It should be noted here that the blighted canes in the Organic Plot noted in October and November were scattered throughout the plot, while all blighted shoots in the Organic and Mud Flow Plots noted after January were entirely confined to the sides and ends of the plots, none appearing in the central parts.

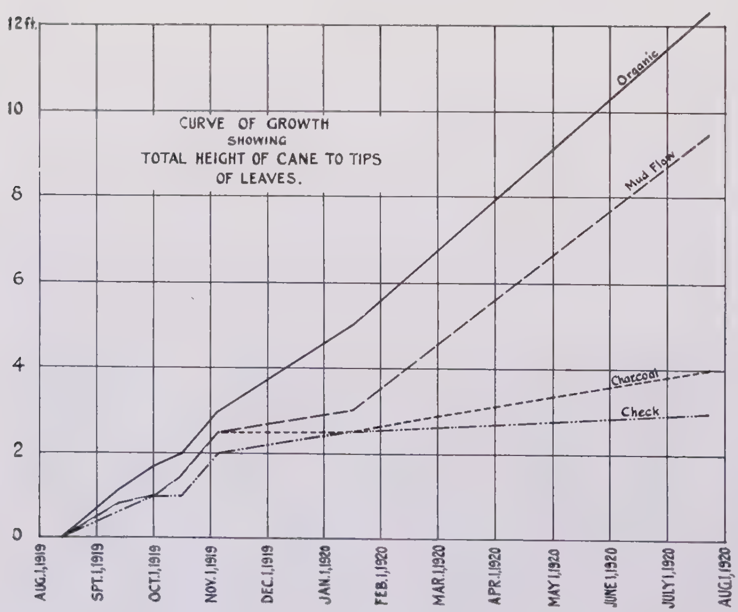
On July 23d, 1920, final observations and measurements were made which are tabulated below:

Plots	Number of Shoots or Sticks	Average Length of Stick	Average Circum. of Stick	Percentage Blight	Total Height to Tips of Leaves	Calculated Tons Cane per Acre
1. Organic	211	47.9	4.415	12.32	12½ ft.	49.8
2. Check	91	0.0	0.0	100.00	3 ft.	0.0
3. Charcoal	130	3.0	2.056	100.00	4 ft.	0.5
4. Mud Flow ..	194	29.2	4.100	0.00	9½ ft.	24.4

During the year two applications of complete fertilizer containing 11% nitrogen have been applied uniformly to all plots, each application being at the rate of 500 lbs. per acre.

Results. The growth of cane as indicated by the height of the cane and the number of shoots shows that the Organic Plot has made an exceedingly rapid growth. The Mud Flow Plot has made practically a normal growth. Neither of these plots has been checked to any extent by blight. In the Check and Charcoal Plots, however, we find a total failure of the cane, due entirely to the ravages of Pahala Blight.





Showing length of stick.
July 23,1920.

In the column of Percentage of Blighted Shoots we find none of the plots showing traces of blight until the end of two months after planting. It was noticed, however, that the cane in all plots had a very poor color up to the first application of fertilizer on September 29th. From the beginning of the third month, Organic, Check, and Charcoal Plots begin to show traces of blight. In the case of Organic Plot, the blight diminishes slightly until February, at which time all blighted shoots in the central part of the plot have recovered. From April on, a heavier blighting takes place in the Organic Plot, but entirely confined to the edges of the plot. In the cases of the Check and Charcoal Plots the blight progresses steadily from the first traces noted in October to a condition of 100% blight in January, from which condition there is no revival. With the Mud Flow Plot we see no traces of blight until February, when a few shoots around the edges of the plot become affected. This condition grows a little worse in April, but a slight diminution is noted in May, with total recovery of all shoots by July.

Conclusions. Taking up the three questions which the experiment was intended to answer we can conclude with certainty that:

1. Pahala Blight can be controlled, if not entirely corrected, by the incorporation of organic matter in the soil, as is shown by the results of the Organic Plot.
2. Pahala Blight is not caused by gases rising into the surface soil, as is shown by the failure of the cane in the Charcoal Plot and the success of the cane in the Mud Flow Plot.
3. The cause of Pahala Blight resides in the surface soil, as shown by the success of the cane in the Mud Flow Plot and the failure of the cane in the Check and Charcoal Plots.

We see here the results of incorporating organic matter. This photograph was taken on May 11, 1920, about ten months after the cane was planted. On the right is the cane in the check plot, which is 100% diseased with Pahala Blight, and has made no stick. On the left is seen the cane planted in the plot where organic matter was incorporated with the soil. The cane tips reach a height of 8½ feet.

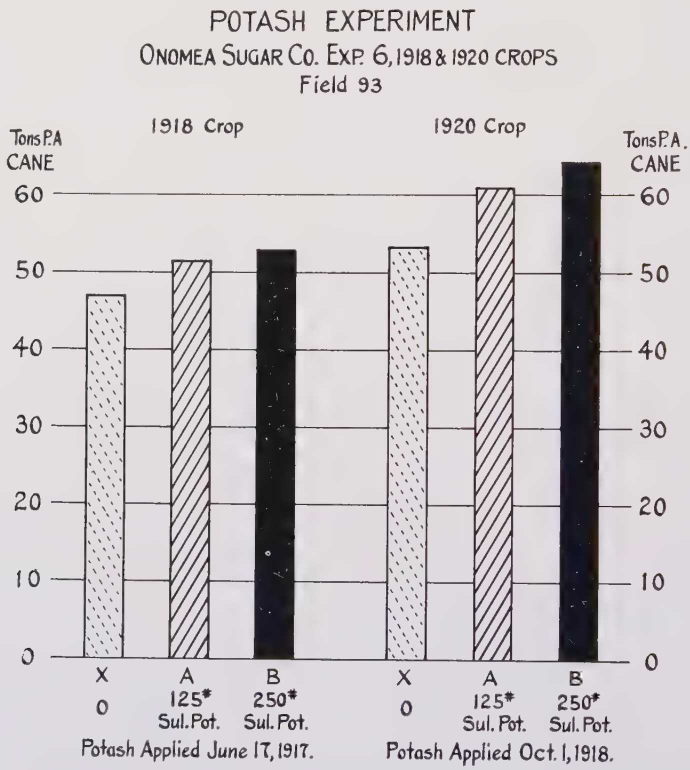
That the cause of Pahala Blight resides in the surface soil is shown by the success of the cane in the mud flow plot on the right. In this plot the excavation was filled with soil transplanted from a field in which the blight has never been known to occur. The cane has made a normal growth, and has demonstrated that the blight is not induced by the sub-soil, or by poisonous gases rising into the surface soil. On the left is seen the plot which had a six inch layer of ground charcoal installed between the sub soil and surface soil. The purpose of the charcoal was to act as a filter to prevent injurious gases from rising into the surface soil from below. That such gases are not a factor has been proven here.

Potash Fertililzation Gives Consistent Gains at Onomea.

ONOMEA EXP. NO. 6, 1918 AND 1920 CROPS.

In this experiment a study was made of the value of varying amounts of potash as compared with no potash. The cane was Yellow Caledonia, second ratoons, long, for the 1918 crop.

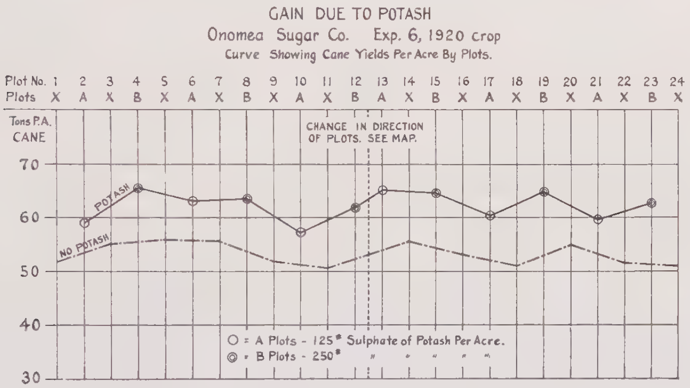
This test was started in 1917, so that the potash for the 1918 crop was not applied until during the second growing season, June 15, 1917. For the 1920 crop, the potash was applied to the young cane on October 18, 1918. All plots received a uniform application of nitrogen of about 195 pounds per acre in three doses.

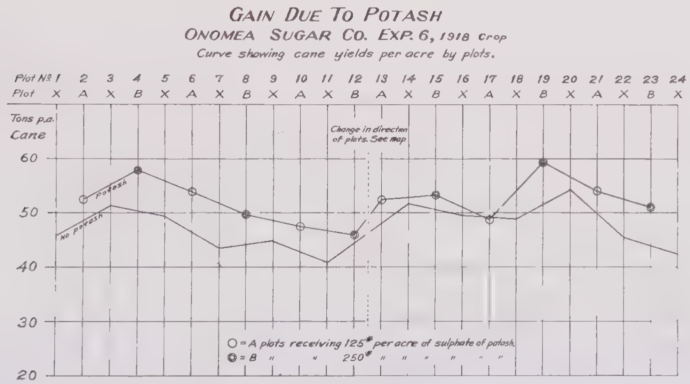


The potash applications and the yields for each treatment for the two crops are given below:

Plots	No. of Plots	Treatment, Lbs. per Acre	YIELDS PER ACRE					
			1918 Crop			1920 Crop		
			Cane	Q. R.	Sugar	Cane	Q. R.	Sugar
X	12	No potash	47.4	8.27	5.73	53.3	8.58	6.21
A	6	125 lbs. sul. pot..	51.6	8.47	6.09	60.9	8.88	6.86
B	6	250 lbs. sul. pot..	52.9	8.37	6.32	64.0	8.41	7.61

The results of the two harvests from this experiment are distinct and positive in favor of potash. In all cases the plots receiving potash produced more sugar per acre than the adjoining check plots. (See plot curve below.) The gains due to the potash were greater in the 1920 crop than in the 1918 crop. This is undoubtedly due to the fact that the potash was not applied to the 1918 crop until during the second growing season.





Results of a similar nature were obtained last year from Onomea Experiments No. 8 and No. 9. For details see *Record,* Vol. XXI, pages 161 and 254.

A composite sample of the surface soil taken from Experiment No. 6 has an analysis of .214 total acid soluble K_2O.

DETAILS OF EXPERIMENT.

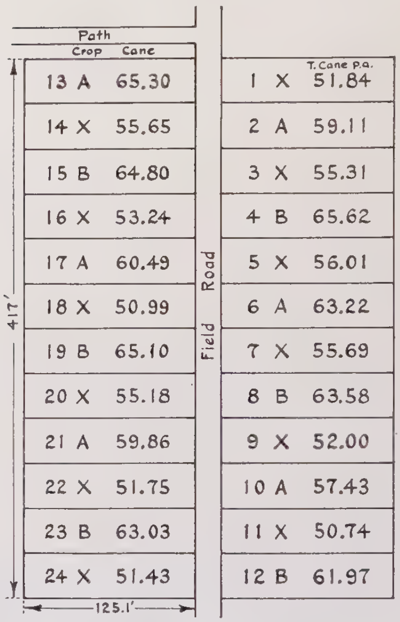
Object: 1. Comparing potash with no potash.
2. Comparing varying amounts of potash.

Location: Onomea Sugar Co., Field 93 (135-acre field).

Crop: Yellow Caledonia. 3rd ratoon, long.

POTASH EXPERIMENT

Onomea Sugar Co. Exp. 6, 1920 Crop
Field 93.



Layout: No. of plots, 24.
Area of plots, 1/10 acre each, consisting of 6 rows 5.79 feet wide and 125.1 feet long.

Summary Of Results

Plots	Sulphate of Potash Lbs. per acre	Yields Per Acre			Gain Over X	
		Cane	Q.R.	Sugar	Cane	Sugar
X	0	53.32	8.58	6.21		
A	125#	60.90	8.88	6.86	7.58	.65
B	250#	64.02	8.41	7.61	10.78	1.40

Plan: Fertilization:

Plots	No. of Plots	Oct. 18, 1918 Sulfate of Pot. per Acre	Oct. 18, 1918 Lbs. W. I. per Acre	Feb. 6, 1919 Lbs. N. S. per Acre	May 16, 1919 Lbs. N. S. per Acre	Total Lbs. per Acre N.	P₂O₅	K₂O
X	12	0	500	500	450	193.75	40	0
A	6	125 lbs.	500	500	450	193.75	40	60
B	6	250 lbs.	500	500	450	193.75	40	120

W. I. = 9½% N., 8% P_2O_5.
N. S. = 15.5% N.

Experiment planned by L. D. Larsen.
Experiment laid out by W. P. Alexander.
Experiment fertilized by G. B. Grant and W. L. S. Williams.
Experiment harvested by W. L. S. Williams, July 29, 1920.

J. A. V. and W. P. A.

The Ewa Concrete Stove.

Industrial Service Bureau, H. S. P. A.

Fig. 1. Stove Factory, Ewa Plantation.

In order to abate the nuisance of open fires for cooking and to provide the labor with some degree of comfort in their kitchens, the concrete stove as shown in Plan 37, Industrial Service Bureau, has been adopted by Ewa, where stoves are being mannufactured in large numbers.

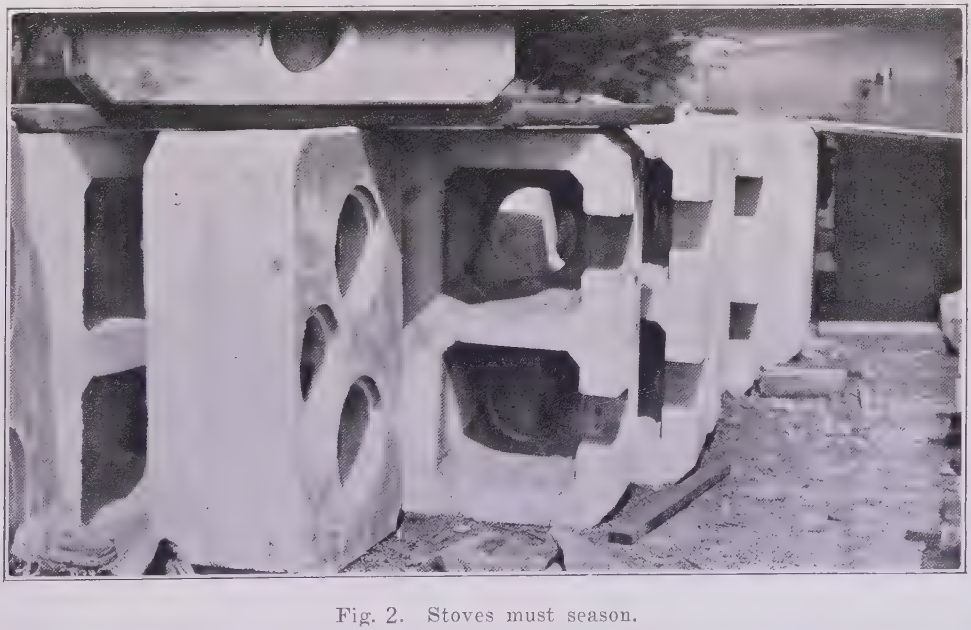


Fig. 2. Stoves must season.

Three weeks are allowed for the stoves to season before they are placed on the bases, which are cast in place. Cast iron rings and plates are installed when the stove is set up.

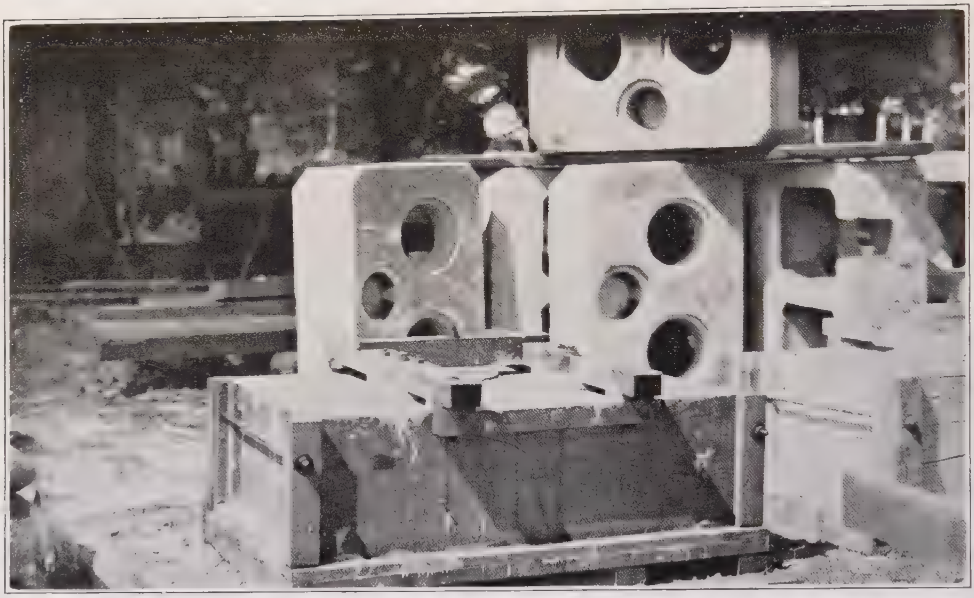


Fig. 3. Well-made Forms.

The forms used are carefully made and bolted together. The stove is cast upside down. Concrete is mixed in the following proportions: (The recess left for the cast iron rings is ⅝ inch deep, 1 inch wide. Outside ring should not be cemented in, as by removing same the large size rice cooker will fit nicely.)

Crushed fire brick 1 in. and smaller, using all sand from crusher	parts	4
Clean sharp sand	"	1
Portland cement	"	1
Fire clay	"	½

This mixture is used throughout, and the stoves are reinforced with ½-inch bars placed around the top.

Phosphoric Acid for Grove Farm—Lihue District.

Grove Farm Plantation Exp. No. 9 (1920 Crop).

This experiment is to determine the value of phosphoric acid on that part of the upper lands of Grove Farm Plantation lying on the slopes of Kilohana Crater. This same soil type extends to the mauka lands of Lihue, and to part of the homesteads back of Makee Sugar Co., so that it would be fair to expect the results of this experiment to apply to the same type of land on Lihue and Makee. Further, observation tests on the mauka lands of Lihue show decided response to phosphoric acid.

Fig. 1. No reverted phosphate.

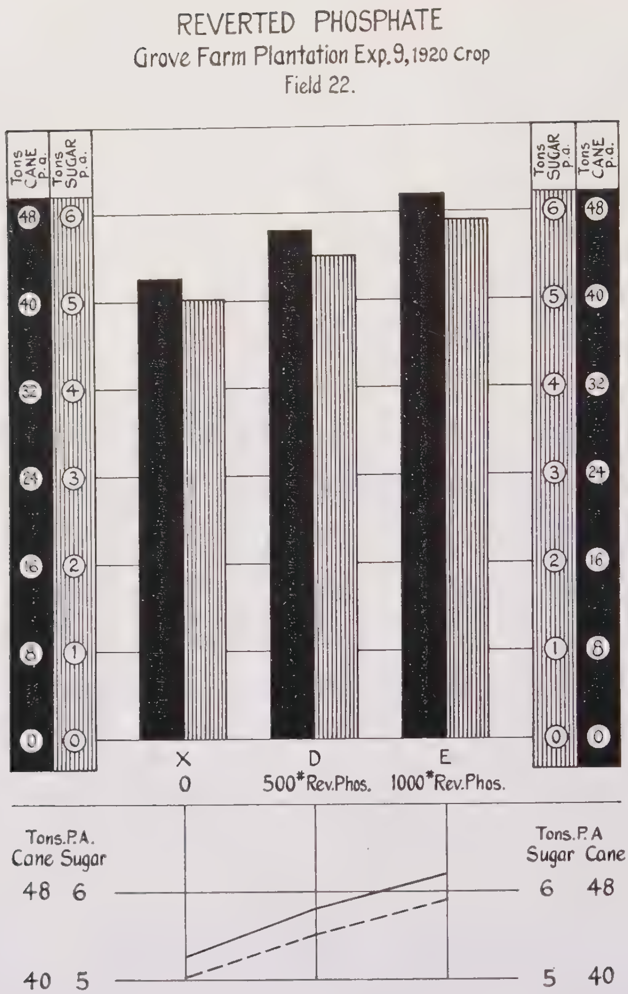
The field in which this experiment was conducted was virgin land. Comparisons were made between 0, 500, and 1000 pounds reverted phosphate per acre. The phosphate was applied broadcast after second plowing, harrowed in, and the field then furrowed and planted.

The response was immediate. When the cane was but six weeks old, marked differences were noted in favor of phosphoric acid. Not only in this particular area was the difference noted, but in the surrounding field the contrast between phosphate and no-phosphate areas was very marked. This difference was plainly discernible during the whole growth of the crop.

The application of 500 pounds reverted phosphate increased the yield by 4.34 tons cane, or 0.5 ton sugar, while 1000 pounds reverted phosphate increased the yield by 7.48 tons cane, or 0.89 ton sugar.

Fig. 2. 500 pounds reverted phosphate per acre.

The cane represented in the photographs above is Yellow Caledonia plant, in virgin land, not irrigated. The cane was planted at the same time and received identical treatment, except that that shown in Fig. 1 did not receive phosphate, while that in Fig. 2 received 500 pounds reverted per acre. (Grove Farm Exp. No. 9, 1920 crop.)



The following table shows the treatments and results:

Plot	Treatment	Tons Cane per Acre	Q. R.	Tons Sugar per Acre	Increase Over No P_2O_5	
					Tons Cane	Tons Sugar
X	0	42.14	8.39	5.02	0	0
D	500 lbs. R.P.	46.48	8.42	5.52	4.34	0.50
E	1000 lbs. R.P.	49.62	8.39	5.91	7.48	0.89

The addition of phosphoric acid has caused practically no difference in the juices, the analysis of which follows:

Plot	Lbs. Rev. Phosphate per Acre	Brix	Pol.	Purity	Q. R.
X	0	18.06	15.80	87.5	8.39
D	500	18.10	15.75	87.0	8.42
E	1000	18.17	15.85	87.2	8.39

This experiment is to be repeated for the 1922 crop.

DETAILED ACCOUNT.

Object: 1. To determine the value of reverted phosphate.
2. Amount to apply.

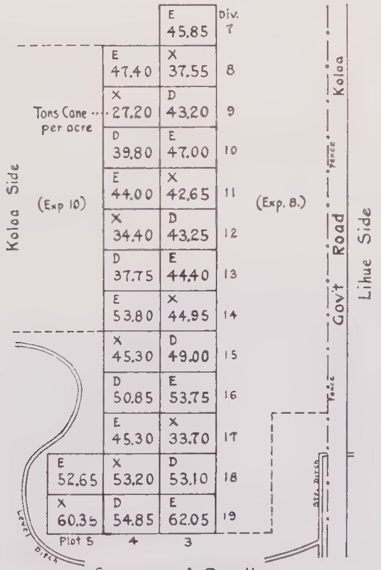
Location: Field 22.

Crop: Yellow Caledonia plant cane on virgin land.

Layout: No. of plots, 27.
Size of plots, 1/10 acre (60′ x 72.5′).

Plots are composed of 13 straight lines 4.7′ x 72.5′, and separated by 3-foot roadways running at right angles to the rows.

REVERTED PHOSPHATE
Grove Farm Plantation Exp. 9, 1920 Crop
Field 22.



Summary of Results

Plots	No. of Plot	Treatment	Yields Per Acre		
			Cane	Q.R.	Sugar
X	9	0	42.14	8.39	5.02
D	8	500* Rev. Phos.	46.48	8.42	5.52
E	10	1000* Rev. Phos.	49.62	8.39	5.91

Plan:

Plots	No. of Plots	Lbs. Rev. Phos. per Acre
X	9	0
D	8	500
E	10	1000

Phosphate applied broadcast and harrowed in.
Fertilization uniform to all plots.
Experiment planned and laid out by R. S. Thurston.

Progress:

May 22, 1918—Phosphate applied.
June, 1918—Furrowed and planted.
June 28, 1920—Experiment harvested by J. H. Midkiff.

R. S. T.

Fertilizer: Amounts to Apply.

GROVE FARM PLANTATION EXPERIMENT 10 (1920 CROP).

This experiment is to determine the profitable limit of nitrogen applications on the mauka lands of Grove Farm lying on the slopes of Kilohana crater.

Comparison is made between 0, 100, and 200 pounds nitrogen per acre, applied in three equal doses in December, February, and June. The following tabulation shows the amounts of application and the yields:

Plot	No. of Plots	Lbs. Nitrogen per Acre	Yield, Tons Cane per Acre	Q. R.	Yield, Tons Sugar per Acre	Increase Over X	
						Tons Cane	Tons Sugar
G	12	0	38.79	8.93	4.34	0	0
H	12	100	42.86	9.07	4.73	4.07	0.39
I	12	200	41.91	9.18	4.57	3.12	0.23

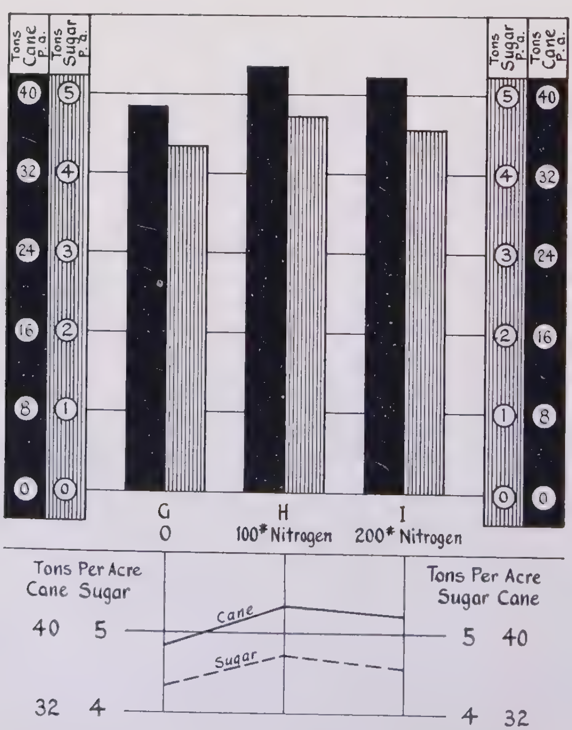
The application of 100 pounds nitrogen increased the yield 4.07 tons cane and 0.39 ton sugar, while 200 pounds nitrogen caused an increase of but 3.12 tons cane and 0.23 ton sugar over no nitrogen.

AMOUNT OF NITROGEN TO APPLY

In addition to nitrogen, all plots received 500* of Reverted Phosphate p.a.

Grove Farm Plantation Exp. 10, 1920 crop

Field 22.



This experiment was conducted on soil deficient in phosphoric acid. When it was noted that this cane was suffering from a lack of phosphoric acid, a uniform dose of 500 pounds reverted phosphate was applied to all plots. This application caused an improvement in the cane, but it never recovered from the early setback. Had this experimental area received phosphoric acid early in the growing season, it is possible that the gains from nitrogen would have been more pronounced.

DETAILED ACCOUNT.

Object: To determine the amount of nitrogen to apply on acid, virgin land.

Location: Field 22.

Crop: Yellow Caledonia plant cane.

Layout: No. of plots, 36.
Size of plots, 1/10 acre (60′ x 72.5′).

Plots are composed of 13 straight lines 4.7′x72.5′, and separated by 3-foot roadways running at right angles to the furrows.

AMOUNT OF NITROGEN TO APPLY.

In addition to nitrogen, all plots received 500 pounds Reverted Phosphate per acre.

Grove Farm Plantation Exp. 10, 1920 Crop

Field 22.

Tons Cane p.a.

Plots 11	10	9	8	7	6	5	Div.
					H 34.45	G 32.40	8
					G 31.05	I 31.50	9
		I 40.45	H 35.75	G 34.00	I 42.15	H 36.00	10
G 46.15	I 51.70	H 59.70	G 35.75	I 36.00	H 41.50	G 35.55	11
I 54.55	H 54.10	G 53.70	I 42.45	H 40.20	G 41.40	I 40.70	12
H 49.10	G 43.65	I 44.75	H 41.50	G 28.00	I 31.90	H 33.30	13
	I 43.65	H 49.50	G 47.30	I 43.10	H 39.20	G 36.55	14

Summary of Results

Plots	No. of Plot	Treatment	Yields Per Acre Cane	Q.R.	Sugar
G	12	0	38.79	8.93	4.34
H	12	100* Nitrogen	42.86	9.07	4.73
I	12	200* Nitrogen	41.91	9.18	4.57

Plan:

Plots	No. of Plots	Lbs. Nitrogen per Acre Applied Nov., 1918	Feb., 1918	May, 1919	Total Lbs. Nitropen per Acre
G	12	0	0	0	0
H	12	33.33	33.33	33.33	100
I	12	66.66	66.66	66.66	200

Fertilizer—N.M.: 15% N. (6% nitrate, 6% sulfate, 3% organic).

Progress:

June, 1918—Experiment planted.

October 30, 1918—All plots given uniform dose of 500 pounds reverted phosphate.

December 19, 1918—First fertilization. Nitrate of soda used instead of nitrogen mixture. No note taken of slight difference in composition between N. M. and N. S.

February 5, 1919—Second fertilization, using nitrogen mixture.

June 6 and 7, 1919—Third fertilization, using nitrogen mixture.

June 28, 1920—Experiment harvested by J. H. Midkiff.

Experiment planned and laid out by R. S. Thurston.

R. S. T.

Termites or White Ants in Sugar Cane.

By O. H. Swezey.

Another instance of termites attacking sugar cane has come to our notice. In a single stool of cane growing in his garden on Piikoi Street in Honolulu, Mr. E. L. Caum found in July of this year a few of the stalks much eaten and hollowed out by the termites, which had worked into the stool from below ground and on up into the stalks of cane. These termites had apparently reached the stool of cane from a nearby fence, which was badly infested with them.

Mr. Caum also found tubers of the edible canna, growing nearby, infested by these termites.

The only previous record of termites attacking growing cane in the Hawaiian Islands was in the case of five stools in a field of the Oahu Sugar Co., on the Waipio peninsula in Pearl Harbor, in July of 1917. An account of this occurrence is given in the *Planters' Record*, Vol. XVII, p. 113, September, 1917. Figures are given of the insects and the sugar cane eaten by them. At that time we did not know the species, though it closely resembled *Coptotermes gestroi* and *C. formosanus*. Since then, it has been given a name (*Coptotermes intrudens*) by Masamitsu Oshima, an entomologist of Formosa, to whom specimens had been sent. The description with figures is published in Proceedings of the Hawaiian Entomological Society, Vol. IV, No. 2, p. 261, June, 1920.

In March of this year this same termite was found to be working in sweet corn on Quarantine Island. It was noticed by Dr. Sweet, who called Mr. Ehrhorn's attention to it. When later investigated by Messrs. Ehrhorn and Williams and myself, it was found that a good many of the living well-grown stalks of corn had been entirely eaten out so that they fell over. The termites had eaten in from below the surface of the sandy soil and worked upwards the same as in the sugar cane noted above. A large pile of old lumber and timbers badly infested with the termites was near the garden, and there were runways in the sandy ground to the injured stalks of corn.

In this connection it should be mentioned that at the Experiment Station on Keeaumoku Street and Wilder Avenue, the fence is very badly eaten with the same termite in many places, and it is very remarkable that no work of the termites has ever yet been found in the sugar cane of any of the plots, even though within a few feet of the fence.

Sugar Refining in the Island of Cuba.*

By H. O. Neville.

The ever-increasing production of sugar in the Island of Cuba and the doubts that naturally arise with regard to the probability of marketing it in its crude state if European production expands and the production of beet sugar in the United States continues increasing, lend interest to the question of sugar refineries and the direct production in Cuba's mills of plantation white sugars. In the past only a very limited number of our mills have produced what are known as washed sugars which have gone into direct consumption in the Island. A few mills have established small capacity refineries at which a small percentage of their crude sugars has been purified, this production also going into the local market. But one large refinery has been established and is in continuous operation, this being the Cuban American Sugar Co.'s plant at Cárdenas. Also smaller plants have been established in connection with chocolate and cracker factories in Havana and others of our larger cities.

But, as we have indicated above, the continued increase in production of crude sugar in our factories and the knowledge that we must seek other markets than those of the United States for quite a considerable percentage of this production, in connection with the fact that in nearly all other markets, especially those of England and France, the demand is for refined sugar, has led a number of the leading men of our sugar industry to think seriously of the establishment in Cuba of refineries for purifying and preparing for the markets mentioned above that portion of our crop which it is believed can be disposed of to them. At the present time, a refinery of 3000 barrels daily capacity is being installed in connection with Central "Limones" by Sr. Lezama, the owner of the latter. A plan has also recently been suggested by Sr. Anibal Mesa to the Association of Hacendados and Colonos that a pool of $10,000,000 be formed among wealthy sugar men of the Island for the purpose of establishing at favorable coast points of the Island three first-class, up-to-date sugar refineries, these to be used as what might be considered a balance wheel for the sugar industry, being operated at times when difficulty in disposing readily of crude sugar occurs, and allowed to stand idle during those periods when the total production of crude sugar in the Island meets a ready demand. This proposal was submitted in the form of a letter to Sr. Miguel Arango, the President of the Association, and in his reply he indicated his conformity with the plan suggested and recommended that serious study be given it.

The utility of such refineries can readily be realized by all those who have been familiar with the heavy demand for refined sugars at almost any price that has been received in Cuba from the United States consumers during November and December of 1919 and to date this year. Millions of pounds of white sugar could readily have been disposed of at very remunerative prices, had these existed in the Island. [R. S. N.]

* The Cuban Review, June, 1920.

Examples of the Work of Plantation Improvement.

Industrial Service Bureau, H. S. P. A.

Illustrating improvements in mill yards.

Single men's club house situated on an Oahu plantation.

Showing old and new quarters on an Oahu plantation.

Two-family apartment house on an Oahu plantation.

Why Industry Seeks Competent Counsel.*

By L. V. Estes.†

There is, perhaps, no more distressing spectacle than to see a home into which sudden illness has come. The agitation and hurried moving around, the anxiety for the signs of the doctor's approach, the feverish consultation among the older people, all indicate the fears that are felt by the family and the hope that they have that the physician will be able to successfully cope with the malady. Every family on some occasion has had such an experience, and each one realizes, at such a time, that he is quite dependent on the doctor's skill and knowledge. No one except a very ignorant or bigoted person would refuse to call on competent outside counsel at such a moment.

The doctor's place in the community is now so well established, and the value of the services that he renders so evident, that the indispensability of his counsel in time of need is taken as a matter of course. No one would be so foolish as to try to prescribe for himself, for if a man who is his own lawyer has a fool for a client, the man who is his own doctor is very likely to have a corpse for a patient. It is recognized that the doctor is especially trained for the work that he has to do, and his standing in the community is established since his competency is attested by the state in which he practices.

The position of the surgeon is exactly analagous. If a broken bone is to be set, if a wound is to be sewed up, the person to whom we most naturally turn is the recognized surgeon. He brings to his task the training that he has received in both university and hospital, and out of his long experience he performs the delicate operation with the practical certainty that it will be a success.

The Consultant Is Recognized in the Business World.

When we turn to the business world, we find that the same thing is true in many instances. No group of business men would dream of trying to incorporate a new company without the assistance of a lawyer, and if the corporation is to be a large one from the start they will unquestionably secure the advice of some attorney who has made a specialty of the matter of incorporating new con-

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* Portion of an Article from Industrial Management, June, 1920.

† From a wide professional experience the author has knit together the reasons why industrial firms seek and employ competent counsel. These reasons are reinforced by the view of the industrial engineer himself as to the advantage that his own counsel and advice may be to the management of a plant that is seeking for improvement and progress. Mr. Loring Vincent Estes became a machinist apprentice when eleven years old and then, successively, a journeyman and foreman of an erecting crew. At twenty-three he entered the United States Navy as second-class machinist; served his enlistment and then held the positions of civilian inspector and master machinist, the first in a private yard, the latter at the Philadelphia Navy Yard. Moving to California he became master machinist in construction and repair at the Mare Island Navy Yard, and under the direction of Mr. Holden A. Evans installed the first efficiency system ever put in a government machine shop. Returning later to the East he held several engineering positions, finally becoming superintendent of the Chicago branch of the Miller-Franklin & Stevenson Company. Afterward he purchased this Chicago business and established it as L. V. Estes, Inc., now one of the largest industrial engineering firms in the United States.—The Editors, Industrial Management.

cerns. Every company that is doing any considerable business consults legal counsel from time to time, some concerns regularly retain it, and a few even have lawyers on their own staff of officials. Even where there are attorneys on the board of directors, it frequently happens that some other lawyer is called in to give his advice, for it is realized that the outside point of view is valuable.

In recent years other classes of expert counsel in addition to lawyers have been called into being by the need that business has felt for them. The auditor who makes a periodic audit of the financial books of a company is now a well-recognized advisor to the business concern. As a result of the connection established by auditing financial books of the company, the business executive began to call on the auditor or public accountant for constructive help to correct the troubles which his audit often disclosed. Thus the expert accountant commenced his work and, though frequently he is at the same time an auditor, he has nevertheless a separate and distinct field of consulting service to offer to the individual business.

The Ever-widening Field of Action for the Competent Counselor.

These are just two of the many forms in which the advice and counsel of experts is made available for the use of the business executive. The list has grown by leaps and bounds in the past few years. Consulting engineers in the structural, mechanical, chemical branches, advertising experts, traffic experts, income-tax specialists, appraisers, are simply a few of the names taken as illustrations from such a list of consultants. Perhaps most important of all, and certainly most inclusive in the scope and effectiveness of the service rendered, is the industrial engineer.

With so many lines of consulting service developing, there must be some fundamental and underlying reasons for the increase. Individual consultants may come and go, but the extent to which they render their service is growing with astonishing rapidity. The reason must be in the value of the service rendered, as business men do not continue to pay out money if they do not get real returns for the expenditures that they make.

The Economy of Employing Outside Counsel.

One of the first reasons, then, for the existence of outside counsel is that it is directly and immediately economical from the business point of view. Small concerns cannot afford to maintain a large staff of highly-paid experts to give them the needed counsel on problems as they arise. Neither can a small concern afford to do without the counsel of experts, if it is to remain in the running, and especially if it is to grow from a little business to a big one. The availability of competent outside counsel solves this problem. He has all the knowledge and training that the expert permanently hired by the big company has, and at the same time it is necessary to pay for his services only when they are being actually used. He is available almost always on call, and when he is employed regularly he soon obtains a familiarity with the particular problems of the company in question that is almost as great as that of the expert who is constantly on the job with the company. The value of continued industrial consulting service cannot be overemphasized.

The Knowledge of Any One Man Is Limited.

As we look further, however, we see that the causes for this ever-increasing demand are far more fundamental and basic than the economy of a few dollars for the smaller concerns. "Ninety per cent of the progress of the world has been made in the last fifty years," said a well-informed man recently. And yet it would have been a rash man 50 years ago who would have claimed more than a very small part of all the knowledge that it was possible to possess. Even such a man as Herbert Spencer, whose grasp of many fields of science was perfectly astounding, whose natural intellect was prodigious, and whose training was unique in its breadth and depth, knew only a small part of all that there was to be known. No really great man has ever been heard to wish for new intellectual worlds to conquer as Alexander sighed for more kingdoms to bring under his sway.

If 90 per cent of the progress of the world in general has been made in the last 50 years, much more than 90 per cent of the progress in the business and industrial world has been made in that time, for business and industry have been the ones to profit most directly by the remarkable discoveries and inventions that have taken place in the material world. Electric motors, for example, have directly benefited the public, as electric fans, washing-machines, etc., have all done much to make life more livable, especially for the mother in the home, but they have helped the public far more through the indirect means of promoting industry. The telephone has facilitated social intercourse, but it has almost revolutionized in some respects modern commercial organization.

Progress Depends on Combining Intelligence.

If the business and the industrial world is considered from the economic point of view, the changes that have taken place have been even more remarkable, though we know that in large measure they are tied up with, and dependent on, the scientific development that has at bottom made them possible. The modern corporation 50 years ago was still in its infancy for the partnership, or personal way of doing business still sufficed for most of the needs of the day. Today, incorporation has fostered the growth of business to such a point that companies are sometimes top heavy, and in many cases their complexity is far beyond the ken of any one man.

This simply means that the intelligence and training of more than one man must be drawn on for the adequate direction of such large organizations as we now see in the industrial and commercial world. The day of the "one man" company has gone by, and the day of the combination of intelligence has come in. The most successful general manager is the one who fully realizes this and who does not try to do everything himself. If every detail must go through his hands for decision, action is very slow in taking place. His success lies rather in his ability to pick and choose the men who can do the things that he wants done, and who can supplement his lack of knowledge in fields where his training and experience have been incomplete. More and more it is being recognized that real greatness and true leadership lies in a keen appreciation of moral and intellectual values, and action based on such understanding rather than in the accumulation

of a mass of facts covering many fields and the possession of the blotting-paper type of mind that will permit the retention of such a conglomeration.

The "Doers" and the "Thinkers."

People may be divided into the "doers" and the "thinkers." This does not mean that the thinker never does anything or that the doers never think. Such an assumption is not at all warranted and is not implied. What is meant is, that some people are primarily occupied with the how and why of things—they are the thinkers, and the others with the when and where—the doers. That is, one group of people is occupied with getting things accomplished and the other group is taken up with the manner in which the accomplishment is brought about. Most of the people in any business organization are of the "doer" class, for the business world exists primarily for the accomplishment of tasks. The making and marketing of goods, with all that this involves, is the principal object of the business world.

The fact, however, that getting things done is the principal occupation of business does not mean at all that the other class of men have no place in the realm of industry but must be relegated to some classification of non-producers, or considered as purely ornamental. Getting things done, doing the same things over and over again, getting out production, is more or less of a tread-mill process when looked at from one point of view. By that it is meant that, just as in the tread-mill a certain amount of power which may be easily measured is delivered each day, and in that sense very definite results are accomplished, nevertheless the tread-mill stays fixed in one place and does not either move in position or increase in its ability to produce power. So in the case of the men who are the ones that make the daily output of the company, the ones who carry on the routine duties or who are occupied in directing them, what they accomplish while easily measured and definite in its benefits, yet nevertheless is not a means for the development of the company.

It is perfectly natural that this should be so and this statement is not intended in any way as a slight on the value of the work of the man who makes the wheels go round day after day. These men have their time and energy taken up in the immediate task of getting definite and tangible results, and they have neither the time nor the strength to allow them to think up new and improved ways of doing their work, to better produce, or discover the means to obtain increased gains or avoid losses.

Accomplishment Depends on the "Doers," Progress on the "Thinkers."

Nevertheless, if the company is not going to stagnate—and that signifies going backward if it does not go ahead—the means for making this progress must be found. Some companies, as has already been noted, keep their own staff of experts. They have a lawyer who devotes his entire time to their interests, they have their own auditors and accountants, as do the railroads, and now many large corporations have their own staffs of industrial engineers to improve the methods inside their factories. These are the thinkers, the men who must see to it their company is always abreast of the crowd, if not ahead of it. Even when

a company has its own staff of experts it sometimes finds it advantageous to call in the outsiders to help them.

A public service corporation that maintains its own appraised engineers recently engaged a consulting firm of appraisal engineers to make a separate and distinct survey of its entire property. This gave them not only a check on the work of their own engineers, but it provided them with a statement by which they were able to show that the rates for their service were not excessive.

Outside Counsel Must Be Competent.

However, outside counsel must be really competent or it is valueless. Poor advice is worse than none at all. The word "competent" has a very definite meaning. A man who is competent to do a certain thing is one who is fitted and prepared for the work which he undertakes to accomplish. He must be adequate and sufficient for the tasks that he takes upon himself. He should be capable of handling his duties in such a way as to accomplish them successfully, and he ought to be qualified to meet the problems that come his way. Too much emphasis cannot be laid on the necessity of the counsellor being thoroughly competent, for much of the opprobrium that is now attached to consulting service in some quarters is due to the fact that some consultants have been in no way fitted for their tasks. The man who is not properly qualified and equipped to render the service that he offers in a satisfactory manner which will lead to beneficial results for his client, is a menace both to those whom he professes to serve and to the profession of which he claims to be a member. None will be quicker to condemn the incompetent consultant than members of his profession who are adequately prepared for their tasks. Such an experience as the following will not overtake a man who is really competent.

Counsel That Was Not Competent.

The general manager of a large company, who is modern and progressive in his approach to the problems that come to him for solution, was not satisfied with the results that he was getting from his boilers. He had studied the matter somewhat himself and had had the chief engineer investigate the question, but still he felt that the greatest efficiency had not been obtained from the power plant. He sought the assistance of an expert in power plant construction and operation.

The expert came, and gravely and seriously studied the problem that was presented to him. He spent hours observing the methods of stoking, and made elaborate records of coal consumption and power output. He investigated the coal and he examined the stack. He then retired to an office and made complicated calculations, and at last made a report embodying certain recommendations.

"The trouble with your power plant," said he to the president, "is that it needs superheaters for the steam. With the installation of superheaters of the proper sort you will increase the efficiency of your power plant 30 per cent."

"Uh-huh," said the president, as a sad, wan smile played around his lips, "so you've been working here for three weeks around our power plant and you

have not discovered yet that we have had superheaters of the type you describe for over a year and a half."

The expert packed up his report and departed, a very much discomforted man. We do not know whether or not he learned his lesson that it is not a wise thing to try to rely on a bluff to carry him where he should have relied on careful study and thorough training, but we do know that if the president had not been a very wise man, as well as a very energetic executive, it would have been the last time that he ever would have called for the assistance of an expert.

What Competency Depends On.

Individual competency in any line of work depends on individual ability developed by training and experience. In no other way can the capacity for successfully accomplishing one's tasks be attained. Natural ability depends on the physical, mental, moral qualities that go to make up a man's character.

Robust physical health and a strong physique that will enable a man to endure hard work, hardship, mental strain, long-drawn-out periods of close application to confining tasks is a great asset for any kind of work. It does not mean that because a man does not have these things that he will not be able to succeed in the tasks that he has set before himself, but it does mean that he will win out under a handicap. Sometimes manual dexterity is also important. The time-study man must be able not only to handle a stop watch with ease, but he must have the ability to handle tools with speed and effectiveness that he may be able to give the man he is teaching a practical demonstration of what is to be done and the way to do it.

Intellect.

The competent counsellor in particular must have a good intellect, for he is primarily sought for what he knows and for his ability to get this information across to the other man. Hence, he must be quick to grasp the problems that come his way. He should be able to analyze them, and to select the essential and eliminate the non-essential. He ought to be able to discriminate between the good and the bad, the correct and the incorrect. What he has found and wishes to retain he should be able to record in a useful and usable form. Much of the progress of which this world is capable is not realized because the man who first finds some new way of doing something, who gets a new idea, who develops some unusual invention, does not record what he has found, discovered, or developed.

Moral Caliber.

Important as intellectual ability is, it is not so important as the moral stature of the man. True it is, in any occupation moral qualities, using that term in the largest sense, are desirable, and in varying degrees essential. In an expert consultant, however, they are the very basis of all that he does, for without them his ability to accomplish his task is gone. They are the very basis of confidence in his work and advice, and if that confidence is lost or destroyed his opportunity for service to clients is past. Integrity, truthfulness, patience, persistence,

energy, sympathy, are a few only of the qualities that competent counsel must be possessed of, if he hopes to attain success. The moral qualities in the more limited sense of the word, such as honor, integrity, fair-dealing, veracity, a sense of responsibility are the very foundation stones on which he builds, and without them there is no foundation that will sustain an enduring structure. More and more are the men who offer their service in a consulting capacity coming to realize this, and as time goes on the standards that they are setting for their professional ethics are being raised uninterruptedly.

Training.

Inherent natural ability remains potential and does not become available for real service till it has been trained. The consultant needs the best of training, and he is fortunate if he can begin at the bottom and build upward consistently. The instruction that a man receives in the preparatory school, the college, university and technical school furnishes him with the tools that he is going to want and gives elementary practice in how to use them. There are many men that do not have these advantages and are obliged to get their training in other ways, often while they are getting their experience. While this means a lot of hard work for them, they are not altogether to be pitied, for they have the opportunity to derive great advantages therefrom. They are far better able to coordinate the practical and the theoretical than their brothers who have been blessed —or cursed—by being members of families that could afford them all the educational advantages.

Experience.

Well-trained natural ability is not enough, however, to equip a man to be a counsellor. He must have had experience, or he will lack the power to make his trained intelligence of use. The so-called "practical" men are very often inclined to make fun of the theoretically-trained men, and say that he is useless when it comes to the test of actual performance. Some of this feeling is undoubtedly justified, but some of it is probably due to a touch of jealousy which they feel that they, too, have not had these advantages. The theoretical man is frequently inclined to look down on the man who has learned most of what he knows by actually doing it, sometimes taking an attitude that can easily be considered snobbish, and forgetting that the practical man puts into effect the theoretical man's knowledge. The real fact of the matter is that there is no good reason for either attitude, for theory and practice should go hand in hand. Before a man can wisely and successfully advise others he must have had both thorough training and wide practical experience, involving the actual doing of the things about which he is consulting.

Specialization and Coordination.

As was stated in a previous paragraph, it is impossible for any one man to know all that there is to know about all the different matters that affect business. Each consultant, while he should have a good general idea of the principles that guide the affairs of the business world, should also be a specialist in some one

particular part of the field. To make the best use of the wisdom of the counsellor it is desirable that the counsellors shall be coordinated and organized. This is the reason why the organizations of consultants that have grown up in the past few years have been so successful. They have taken the specialized knowledge of each member and united it to that of each and every other member. In this way they have provided support for every man in the organization, for he knows that his own lack of information when he gets outside his own particular field will be supplemented by the specialized knowledge of his colleagues.

The service that can be rendered to a client by such an organization is much greater than could be performed by each of the specialists working separately, for the efficiency of the service rendered is greatly increased. It is not necessary to go to several experts for desired advice, for all are grouped in one organization. All the records of the consultation provided will be kept in the main office of the consulting organization, and will be there available at any time for reference. No client need fear that valuable information will be disclosed, for it would be the height of professional indiscretion for a firm to give away its clients' secrets. At the same time the information of general interest that might be obtained by a consultant while working for a client would be put in a place where it would be at hand for the use of the other consultants, and not be lost because it is buried in the archives of a single concern. This makes the experience of one client available for the good of all, and each client can benefit from the accumulation of past experience made in this way.

Organized Consultants.

An organization of consultants is able to offer a client better service because it is able to maintain a research department which is constantly studying the difficult problems that come up and hence is ready to furnish any of the consultants information that they may need and have not had the opportunity of obtaining. This research department keeps in touch with all the latest books and periodicals, and through them it obtains the most up-to-date information that is published in regard to matters that may be germane to the work of any of the consultants. It also reviews the work of all of the experts to discover those things that they may have done which are original and which hold the possibility of being of value to the other members of the organization.

The Psychological Advantages of Outside Counsel.

The reasons why it is desirable to call in outside counsel are based on fundamentally sound psychological foundations. In the first place, the outside counsel brings to the problems that are confronting his clients an unbiased and unprejudiced viewpoint. He is not confused by having worked, with those problems always before him, till he is unable to obtain any but a distorted view of them. It is not intended by this to disparage in any way the attitude of the men who are daily doing the routine work. Prejudices are perfectly natural things to have. Habits are easy to acquire and are hard to lose. Habits—and prejudices are nothing more than likes and dislikes which are founded on certain

habits of thought—are one of the chief reasons why the man who does routine work can do it so expeditiously and well.

The very element of fixity in habit—that is, one of its virtues when work is looked at from the point of view of accomplishment of regular tasks—is a hindrance when it comes to the point of making changes and improvements. When betterments are to be made we need the kind of man who is always looking for something new, who has the quality of imagination, who is able to see beyond the present and behold in the future the accomplishment of that which he has conceived. The kind of man who is needed is the one who likes to go out into the unexplored regions of the earth, who likes to delve into the mysteries that science always holds before the investigator.

Keenness of Observation.

We all know that old expression which says that a new broom sweeps clean, especially as applied to the work of a new comer. This is perfectly true, for not only does an outsider come to the problem to be solved without the prejudices of long association with it, but he brings with him the freshness of viewpoint that is sensitive to all impressions. When we live along with a certain set of surroundings we become so accustomed to them that we are not aware of the details of which they are composed. It is the things that we come most in contact with that we observe the least. If you see a man look at his watch and then 30 seconds afterwards ask him what time it is, he is almost sure to look at his watch once more before he replies. Ask the same man to draw a rough sketch of his watch without looking at it, and when he has finished let the sketch be compared with the face of the watch and almost invariably there will be differences in essential details.

The same thing holds true in the business world. A particular method of filing may be out of date and difficult of operation, but it will still be used because no one in the organization has happened to see that it is obsolete. Steam pipes in the factory may be left exposed in places where the radiation is great and where the need for warmth is nil, and yet, because they have always been that way the master mechanic will pass them by unnoticed, though he would be the first to remark a similar condition in another factory that he might visit.

These are just two minor illustrations of a sort of thing that often happens with much larger matters. How often does it happen that a company allows its accounts receivable to run along month after month in such a way as to entail heavy drain on the profits, even if it does not wipe them out entirely, simply because they have become accustomed to it. Frequently a concern limps along with an imperfect organization or even none at all, and blames its lack of control of production, its failure to live up to promises of shipments, its meager profits, its trouble with its employees on the head of some one or few individuals when really the entire difficulty is due to the fact that the work is not so organized that even the best group of individuals in the world could accomplish it successfully.

Freshness of Viewpoint.

The outside counsel who comes in with the fresh, new point of view will be the first to see just these things. They will strike him vividly and at once, for even if he is familiar with the same kind of thing in other places, the surroundings will be so different that it will lose none of the freshness of newness as far as he is concerned.

The man from the outside will be able to get an entirely different view of the company and its problems than will anybody inside. He will have what is known as a perspective of the whole business, and perspective is one of the things that is most needed. If you ever saw a photograph of a twig taken at very close range and with nothing else near at hand with which you could compare the size, you probably had difficulty at first in telling whether it was really a twig or a branch. In other words, there was no perspective and means of comparison—the view was, in a way, distorted, for it did not give you a correct impression of what was actually represented.

The same thing is true in business, for the man who is constantly on the job at all times is frequently like the man who was so near the woods that he could only see the individual trees and could get no conception of the real size of the forest. In other words, he cannot grasp the whole of what he is looking at, for he is so close to it that he can see only the details.

Perspective.

The consulting engineer is in a position to get just these lacking perspectives or reviews. From his experience with many outside concerns he is able to correctly evaluate the status of the company that he is counselling. He can place it in its correct relation to the other business concerns in its class. The same thing is true in regard to what he finds inside the company, for it sometimes happens that matters which seem of small consequence because they have become habitual, when seen in their proper light and compared with similar conditions in other places, will be found to have an importance far beyond what was realized. For instance, overdue accounts receivable may be quite steady in the ratio that they bear to the total accounts receivable, and yet be far too high when compared with the same percentage among other concerns. The value of raw stores carried may not seem excessive to the managers till they find out that their competitors are doing business with much less of their capital tied up in this manner. A discovery of this kind can rarely be made by a man who is familiar with one company only.

It is obvious that the outside counsel will not know all the ins and outs of the particular concern he is called upon to aid. When a manager says that his business is different from every other business he is right to a certain extent. It is perfectly true that no other company has to meet exactly the same problems in the same form. Differences in location, differences in markets served, differences in the personalities that are at the head of them, and many other differences, all conspire to make the particular problems before any company just a little different from those of any other company. This fact has often served to deter the employment of outside counsel when really this fact should be one of the strongest reasons for calling on him for advice.

Breadth of Experience.

The outside counsel brings with him the broad experience with many different concerns, some in the same line of business and some in others. He brings breadth and a knowledge of general principles and policies, experience with varying conditions and men that gives him more than the usual balance and poise and enables him to aid most effectively the men in the company who already have the details of the company's business at their finger-tips. What the general manager wants when he calls for outside counsel is not the acquaintance with detail that he naturally expects of those who are handling the routine work day by day, but the largeness of viewpoint which comes from handling many different projects. Hence the expert's lack of familiarity with details is an asset to the outside counsellor, for it enables him to retain his perspective, keep out of the ruts, and exert the influence of his prestige that comes with many successfully accomplished tasks. * * *

[R. S. N.]

Oils for Power Plants.*

By C. B. Whitman.†

Take a wine glass, dip your finger in water and as you rub it over the edge of the glass notice that the friction is pronounced; now wipe the finger dry and dip it in glycerin and again rub the glass—the friction is about the same. Dip the finger in lubricating oil and rub the glass. You find that the friction is almost imperceptible, which demonstrates that while glycerin has a viscosity far greater than the oil its lubricating quality is lacking, because the surface tension of either water or glycerin is not strong enough to form a substantial film, even under very light loads, for they are both lacking in capillarity and in molecular attraction. For this reason many very viscous liquids fail to form a good lubricating film.

This also demonstrates that to be a good lubricant a liquid must have nearly as great a surface tension as a solid, also that its lubricating value depends on the thickness of the layer it forms when spread over the surface and the resistance it offers to the efforts of the load to expel it from between the solid surfaces.

Little is known about the properties of liquid films other than that which is obtained from the frictional data. The static friction of solid surfaces when lubricated with lard oil and sperm oil prove that the lard oil gives the lowest coefficient and therefore must form the thickest film. Experience teaches that when the superfluous oil has drained away the combined capillary and molecular attraction comes to the aid of the viscosity and increases the tensile strength which tends to prevent rupture.

* From a paper read at Buffalo, N. Y. Pub. in "Power," July 6, 1920.
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Molecular and capillary attraction are possessed to a greater extent by mineral oils when properly refined, than by either animal or vegetable oils, but mineral oils are deficient in oiliness and will not keep the static friction as low as do animal or vegetable oils.

At speeds of 500 or more per min., under normal loads, and with bath lubrication, lard oil will sustain a film of only 0.005 in. thick, whereas a pure mineral oil of the proper viscosity will sustain a film of about 0.007 in. thick, which proves that for all ordinary machine bearings running under normal conditions, a mineral oil of the proper viscosity is a better lubricant by two-fifths than one of the best-known fixed oils. This has led to the blending and compounding of mineral oils. Blended oils are a mixture of mineral oil and fixed oils in proportions that will thoroughly neutralize; compounded oils are a mixture of mineral oil with metallic soaps of different kinds for the purpose of increasing the viscosity; experiment alone can tell as to the value of the mixture; often they are more detrimental than beneficial from a lubricating point of view.

As lubrication is of value only as its ability to reduce friction, we must consider the circumstances that influence friction. Cohesion is aggravated rather than diminished by efforts to produce smooth surfaces, for the more perfect the surface the greater will be the points of contact. At minute distances molecular attraction increases, which causes the surfaces to adhere and resist motion. For example, pieces of marble with polished surfaces will adhere when pressed together and their cohesion is so great that one piece when suspended will sustain the weight of the other. Again take two pieces of lead, scrape them clean and press them together in a vise and they will adhere almost as firmly as if they were one.

Of course the pressure to accomplish this is far greater than we get on a bearing, and I merely use these examples to show that there is cohesion between smooth surfaces. In a bearing the increased friction caused by motion generates heat, which increases the tendency of the surfaces to adhere, the area affected rapidly spreads and the surfaces seize or abrade each other. This happens in a "hot box."

The coefficient of friction of motion is the only one of interest from a lubricating point of view, and it is defined as that value which, when multiplied by the pressure normal to the surfaces in contact, gives the measure of the maximum frictional resistance to motion.

The value of viscosity and density of oils depends on the viscosity of the lubricant, the relative speed of the surfaces, their area and inclination to each other, thickness of the lubricating film. When these conditions are known, the resistance to the motion of any given body can be easily calculated.

To properly lubricate the different bearings found in modern practice, it is necessary for the lubricating engineer to know, first, the oiliness or greasiness of all lubricants, the frictional effects due to the viscosity of the lubricant, effects due to the different methods of application, the effects produced by different metals working in contact, the effects of temperature on friction and viscosity, and the effects due to different speeds under given loads. When the speed of the rubbing surfaces is less than ten feet per minute, the lubricant, instead of being forced between the surfaces and keeping them apart, is swept on under pressure, and the lubricant depends as much on its oiliness as on the viscosity.

Solid lubricants such as mica, graphite and soapstone have great carrying power at low speeds, but their value depends as much on the nature of the surfaces. Graphite, for instance, gives the best results when used on cast-iron surfaces, which are naturally very porous and hold the graphite, but the frictional loss and wear are great. Solid lubricants mixed with animal fats, greases, vaseline or rosin oil are suitable for low speeds and heavy loads, as they give a low coefficient and do not waste away rapidly by evaporation nor run off the bearings. Greases compounded from animal and vegetable fats, or mineral oils emulsified with water soap and alkali enough to neutralize them, are good lubricants for slow-moving bearings with excessive loads, provided the oils do not contain too much water and are not adulterated with foreign substances; the oil should not run down and leave the soap, which is liable to occur in poorly made greases.

Properties of Lubricating Oil for Low Speeds and Heavy Loads.

In selecting an oil for low speeds and heavy loads, viscosity is the first guide, and next is oiliness. At speeds of 100 ft. per min., with proper application, as before stated, the oil forms a fairly thick film, and when the load does not exceed 250 lb. per sq. in., the formation of the film and the friction are wholly due to the viscosity; but at heavy loads the bearing surfaces are brought into contact at a point on one side of the bearing and the lubricant should possess oiliness to a greater degree to prevent seizing. In cases of flat surfaces, such as the guide on reciprocating engines, the viscosity is not quite so important as the oiliness; at loads of 75 lb. per sq. in. a blended lubricant is best.

For motors, generators, turbines and the crankcase type of high-speed engines, best results are had by using a straight mineral oil of the proper viscosity. For motors and generators with bath-ring oiling devices best results are obtained by using a pure mineral oil of a viscosity of from 120 to 198 (Saybolt) according to speed and load. Turbines having either forced or circulating lubrication should have a light oil for two reasons: First, because the lighter oils maintain their viscosity better at the relative high temperatures, and second, on account of the high speeds. It must also be an oil that will not emulsify and one that will readily separate from water, as there is leakage of steam in most turbines. The viscosity should not be less than 98, nor more than 120 at 100 deg. F.

For steam-cylinder lubrication there are four conditions met with in modern practice that form a guide in selecting a proper oil; namely, steam supersaturated, saturated, dry, and superheated. For a supersaturated condition the oil should be heavily blended with pure tallow to give good results; for a saturated condition a light blend of tallow and blown rape will give good results; for dry steam about 6 per cent blown rape gives good results, but for superheated steam one must have a pure steam-refined mineral oil, otherwise the intense heat will burn off the animal and vegetable oil, release the acids they contain and pit the cylinder walls.

[W. E. S.]

Electrification of Mills.*

By Charles Griffith.

The main advantages of electric drive are not at first apparent. It does not appear that the machines can be more advantageously driven by electric motors which receive electric energy from an electric generator, which in turn is driven by a steam turbine, than by a steam engine direct.

A decrease in operating expense and an increase yield results from the use of economical direct motor-driven centrifugal pumps, the electrification of all mechanical drives and the decrease in the exhaust steam from the centralized power generating equipment.

When the output of a mill is to be increased by equipment of greater capacity, it will be found that this can be accomplished at a minimum cost by the coincident substitution of electric drive. Also the capacity of the sugar apparatus of a mill can be increased by the change over to electric drive. To obtain the maximum benefits, however, it is usually necessary to make some slight changes in the sugar apparatus to balance the capacity of the several stations. The saving in operating expense and the increased yield pay for the cost of changing over an existing mill in two or three years.

When a new mill is considered, there are additional reasons for adopting electric drive. The motor-driven machinery costs less, it can be more advantageously placed, it is smaller and lighter and costs less to install.

Practical Tests.

The new mills in Cuba, and those that have been changed over to electric drive, have demonstrated the reliability, economy, and superiority of the electric drive.

Rare is the steam-driven mill in which the bagasse is sufficient to evaporate the juice, and which also gives a fair yield. The consumption of fuel in addition to that furnished by the bagasse has been found to be productive of increased profits in a well-designed steam-driven mill. This fuel is required to evaporate the maceration water. The economical proportion of maceration water, and hence the additional fuel, is dependent upon the market price of sugar and the cost of the coal or wood used.

On the other hand, in a well-designed electrically-driven mill, the bagasse is more than sufficient to evaporate the normal juice and the maximum effective degree of maceration water can be applied, which results in a high yield. The bagasse becomes sufficient, due to the reduction of the total power required, the

* Facts About Sugar, July 17, 1920. A reprint with slight condensations of an original contribution to the South African Sugar Journal for April, 1920.

decrease in the amount of steam required per horse power of work, the smaller radiation and leakage losses, and the increased efficiency of the heating, evaporating and cooking apparatus.

It has been demonstrated that power can be generated from a large steam turbine and transformed through an electric generator, transmitted to motors, and transformed to mechanical work at the driven machine more efficiently than by a large number of small steam engines and steam pumps.

The adoption of the electric motor permitting the use of high speed centrifugal pumps tends toward a smaller amount of power required for pumping.

Saving in Steam Requirements.

The amount of steam required to produce the same amount of useful work is materially reduced, mainly by the generation of power from a large steam turbine instead of in a large number of small steam cylinders. The amount of steam required per horse power in a steam cylinder operating by throttle control or non-expansively between the limits of pressure common in sugar mills will range from 75 to 100 pounds, whereas the amount required by a Curtis steam turbine operating expansively between the same pressures will be half of the lower figure. This amount can be further reduced by higher steam pressures and super heat to which the steam turbine is eminently suited, but which is detrimental to the operation of the steam engine.

A detailed study of a mill producing 179 tons of sugar per day discloses the fact that electrification would remove 7500 square feet of high and low pressure piping serving steam pumps and engines. Conservative estimates of the radiation losses showed that the loss of heat from this cause alone accounted for 20 per cent of the fuel bill.

The labor item in a mill constitutes the greatest proportion of the manufacturing cost. In normal times it ranged from 4 to 10 per cent of the total cost of the sugar, depending upon the country. The great increase in wages during the last few years makes the reduction of the manufacturing force very desirable.

The reduction in the number of attendants by electrification is apparent. A detailed study was made in a steam-driven mill of the number of operators and repair men which would be affected by a change over to electric drive. After computing the wages paid chargeable to the steam engines and pumps and determining the attendants known to be required with electric motor drive, it was found that the electrically-driven plant would reduce the manufacturing and maintenance labor £8 per day. This mill was producing 1,100 bags of sugar, of 325 lbs. each, per day. This results in a reduction of a shilling per ton of sugar. The force would be reduced by 26 men. This reduction also effects a reduction in the clerical force in the general office.

Reduction of Supplies.

The reduction of the supplies in a mill by electrification is a very strong argument in favor of the adoption of electric motor drive. Lubricating oil and pump and engine piston packings are big items of expense. The electric motor and

centrifugal pump consisting of only revolving elements mounted in oil ring type bearings require a very small amount of oil.

The pump packings surrounding the rotating shafts last a long time. The steam turbines and generators in the power house have similar oiling systems and likewise require very little oil.

In the steam-driven mill the lubricating oil runs from the bearings or is carried off by the exhaust steam and becomes a source of trouble, either by collecting on the engine, pump or floor, or being carried into the steam heating coils and calandria. In an electrically-driven mill, however, the oil returns to the oil wells of the pump and motor bearings, and is again carried up on to the shafts and thus used over and over again. No oil is used inside the turbine, so that the exhaust steam is entirely free from oil.

The oil, grease, packing, waste, pipe coverings, soda, re-agents and replacement of worn-out parts in a steam-driven mill average 2s. 4d. (56.77 cents) per ton of sugar. Of this amount a saving of at least one-third is effected by electric drive.

Continuity of Service.

Continuity of service in a sugar mill is of the utmost importance as affecting manufacture. It is customary to operate the mill to the utmost capacity during the harvesting of the crop. Any shutdown period reduces the amount of cane ground, and as the labor expenses and fixed charges go on, the cost of manufacture is thereby increased. Electric drive has won the reputation of being the most reliable means of power application.

There are many cases of continuous operation of electric motors for periods of several years without a shutdown due to the electric system. The majority of interruptions in a cane sugar mill are from slipping of the rolls and repairs necessary to the steam engines and steam pumps.

Engines frequently stop on dead center or at the end of the stroke, and time is consumed in getting started after repairs or adjustments have been made. The shutdown periods of mills from slipping can be practically eliminated by electric motor drive through the indications of the power meters of the individual motors. By a readjustment of the relative speeds of adjacent sets of rolls, the rolls can be made to take their proper division of the load, and slipping is prevented.

Cheaper Water Supply.

A supply of pure fresh water is required at all mills. This water is usually obtained from a nearby stream or well, and must be pumped to the mill. The distance from the mill makes it necessary with a steam-driven mill to provide a boiler plant with the necessary attendant. The small size power plant, and the constant services of an attendant bring the unit cost of water delivered to the mill to a high figure. The unit cost of water at an electrically-driven mill, on the other hand, is low owing to the decreased costs of pumping. No boiler plant is required at the pumping station, as the electric power can be transmitted over a transmission line from the mill.

The electric drive of repair shops is attended with similar economies. While machine shops are commonly located in the mill building, carpenter shops are usually in a separate building and have their own boiler plants. The saving in fuel and labor is difficult of determination, as they are run so irregularly.

The fuel consumed by the machine shop will be less with electric than with steam drive, due to the higher efficiency of the higher power united in the main power house. It may be assumed that the carpenter shop operates from waste wood, but a fireman is necessary for the boiler.

In Repair Shops.

The electric drive is particularly of advantage in repair shops where the operating periods are irregular. The tools can be started up at any time without waiting for steam or for an engine to warm up. Where the tools are individually motor-driven, power and hence fuel are consumed only while they are in operation. Tools can be located at points most convenient for their use.

In stating the benefits of electric drive an attempt has been made to place a money value on the savings. This is possible of quite accurate determination in the case of fuel, labor, supplies, and repairs. But for increased yield, shut-downs, and pumping of supply water, certain assumptions must be made. For other items, such as repair shops, transport and administration, local conditions vary so widely that it is not feasible to evaluate the expense or savings. These must be determined from a study of the individual mill.

The savings from the definitely determined items are so great that the decision to electrify can be made on these alone. Moreover, these figures have been taken from data collected on a conservative and impartial basis. Details have been given as far as is possible in so brief an article, so that a mill owner can compute the figures applying to his own mill.

Figures from Cuban Practice.

Below is a table summarizing the various items on a basis of the average Cuban mill producing 102 tons of sugar per day, or a total of 15,900 tons in a crop of 156 days. The aggregate savings are considerable and will pay for the cost of changing over an existing mill in a very short time. If only the interest on the added investment is considered, the net saving per year increases the net profits by a large amount. The market value of a mill is increased by a greater amount than the cost of the improvements. (*Note.*—In reprinting the table the figures given by Mr. Griffith have been converted from British to United States values.—Ed., "Facts About Sugar."

	Steam	Electric	Saving
Fuel (additional to bagasse)	$12,093	$.....	$12,093
Labor (manufacturing)	43,526	40,046	3,480
Supplies	9,022	5,961	3,061
Repairs	27,569	26,118	1,451
Shutdowns (labor)	598	......	598
Water supply and miscellaneous	2,311	......	2,311
			$22,994
Increased yield (maceration)			32,240
Total reduction per year			$55,234
Reduced cost per ton sugar			$3.41

[R. S. N.]